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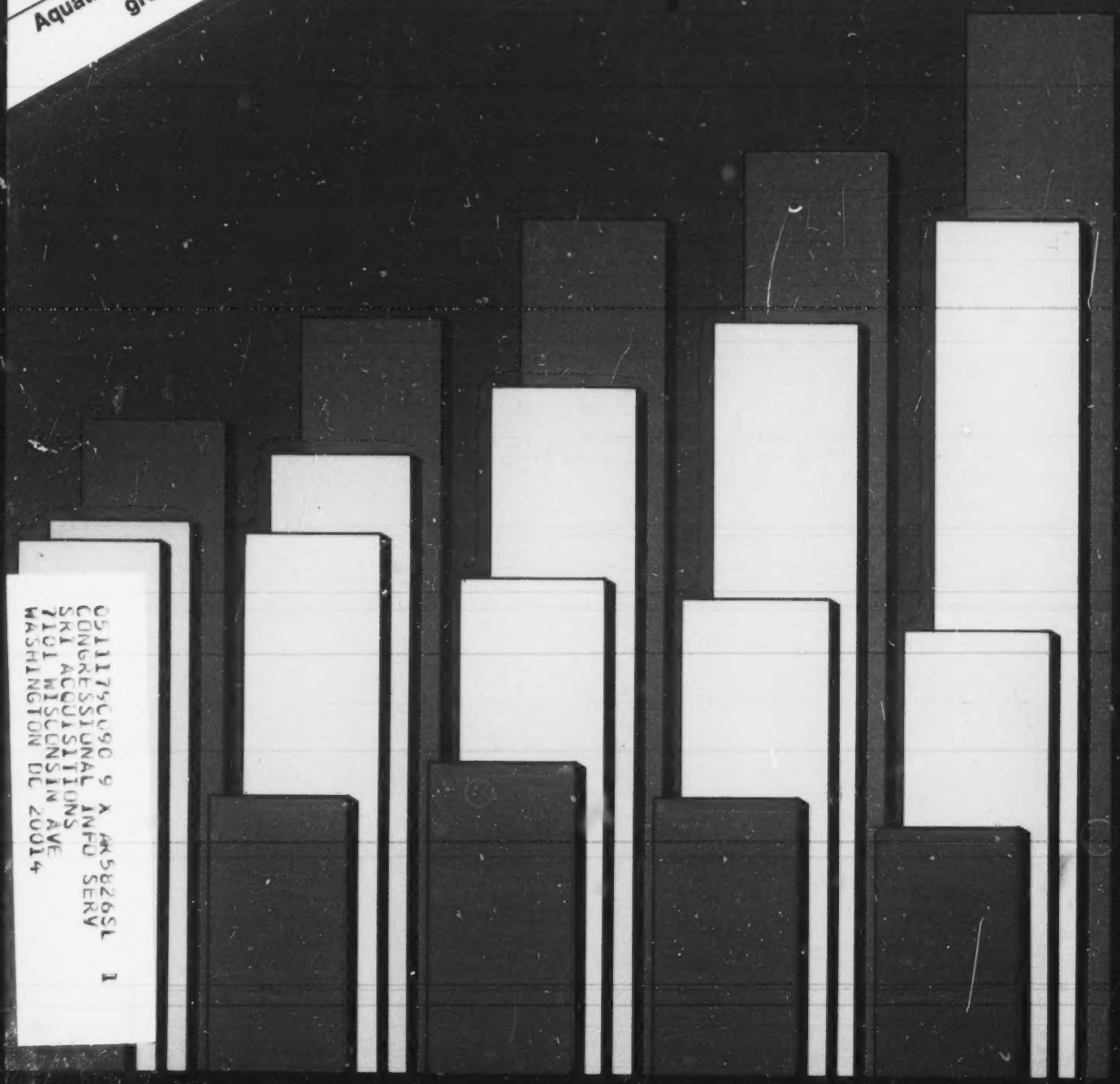

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- ***Dye industry organization*** *asks change in law that permits OSHA to issue health hazard alerts.* ***Page 5***
- ***OTA study stresses restraint*** *in oil shale development to keep social and economic problems at the minimum.* ***Page 5***
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Second Top 50 chemical firms a diverse group

Second 50 are more widely spread through U.S. industry than Top 50, have chemical sales ranging from about $150 million to nearly $1 billion

William F. Fallwell
C&EN, New York

Although not the place for a company without a lot of investment money and technology, commercial chemicals are far from being another auto or steel industry with only a few important producers. In fact, the spread of chemical operations through companies nominally making something completely different makes the very definition of the chemical industry a problem.

This diversity also gives rise to conflicting notions on the relative success of various chemicals under various parentage. Is it better to be big or small, commodity-oriented or specialized, organic or inorganic, oil- or natural gas-based, free-standing or buried in a conglomerate?

Some answers to these questions have emerged with C&EN's addition of a second Top 50 survey to its annual Top 50 listing (C&EN, May 5, page 40). These companies are ranked by worldwide basic chemical sales, not total sales. Since chemical sales for the 100th largest company are about a fairly low $150 million, the two surveys combined probably cover about 95% of all sales by U.S. basic chemical producers.

That 95% comes to about $110 billion for 1979. Within this total, there is a big difference between the smaller 50 and the larger 50. The first 50 account for about $90 billion of the total, and the second 50 for about $18 billion. Thus, the average chemical sales of the largest group are $1.8 billion, and for the smaller group $360 million.

The range in sales is also much smaller for the second 50 group. Whereas the Top 50 starts with Du Pont's $9.7 billion and ranges downward to less than $600 million, the second 50 covers a range of only a few hundred million dollars.

There is officially some overlap between the sales ranges of the two surveys because of the varying purity of company figures on their chemical sales. The first six companies in the second 50 list, starting with Goodyear, are all larger than the 50th company, NL Industries, on the first list. All six, however, mix in a variety of nonbasic chemical sales in their chemical sales figures and possibly wouldn't make the first 50 on basic chemical sales alone.

The seventh company in the second 50, Georgia-Pacific, is slightly ahead of NL Industries and probably should have been on the first 50 list. Otherwise, all companies in the second 50 are below the cutoff for the first 50.

The second 50 group is still not complete, reflecting the state of industry disclosure. Although companies have opened up considerably in the past few years in product line data, in part from nudging by the Securities & Exchange Commission, figures still leave some gap for chemical operations.

There are at least 12 companies whose chemical sales cannot be estimated properly but which should be on the second 50 list. Six of these are foreign-owned, four are highly diversified nonchemical companies, one is a cooperative, and one is private. Together, they have chemical sales of about $4.5 billion for 1979.

The foreign-controlled six are Henkel, Hoffmann-La Roche, ICI U.S., Sandoz, Soltex, and U.S. Borax. Henkel has reported its U.S. chemical sales in the past but later in the year.

The U.S. companies with unknown chemical sales are Avtex (private), CF Industries (cooperative), General Electric, Procter & Gamble, Sun, and Signal Cos. General Electric and P&G still issue annual reports reminiscent of 20 years ago in their lack of detail.

The variety in corporate type for this dozen is even more true for the companies on the second 50 list. They are much more widely spread through U.S. industry than are companies in the Top 50 group, which is dominated by chemical and oil companies. Al-

Second 50 chemical producers differ strikingly from Top 50

The U.S. chemical producers that rank 51st to 100th in terms of chemical sales are quite a different group from the Top 50 (C&EN, May 5, page 40). On average, the group of smaller firms doesn't have relatively so great a stake in chemicals as do the larger producers, and their chemical operations aren't growing so fast percentagewise. In absolute size, the second 50 pale beside the first. However, the second 50 are not dominated by chemical and oil companies. And the parent firms of the second 50 chemical operations generally are more profitable than are the Top 50 parents.

	Second Top 50	Top 50
CHEMICAL SALES		
Total	$18.2 billion	$90.2 billion
Average size	$360 million	$1.8 billion
Average 1979 growth	22%	26%
Average % of total company sales	37%	49%
PARENT COMPANY TYPE		
Chemical	19	29
Petroleum, including natural gas	8	14
Drug	4	0
Tire	4	1
PARENT COMPANY PROFITABILITY		
Average profit margin	7.5%	6.1%
Median profit margin	6.7%	5.9%
Average return on stockholders' equity	17.1%	16.5%
Median ROE	16.9%	15.7%

Most chemical producers in second Top 50 have chemical sales less than $500 million

Rank 1979	Company	Chemical sales 1979 ($ million)	Change from 1978	Total sales 1979 ($ million)	Chemical sales as % of total sales	Industry classification	TOTAL COMPANY Net income ($ millions)	Profit margin[a] Per cent 1979	Profit margin[a] Rank 1979	Return on stockholders' equity[b] Per cent 1979	Return on stockholders' equity[b] Rank 1979
51	Goodyear	$985[c]	17%	$8,239	12%	Tires	$146.2	1.8%	46	6.8%	45
52	3M	821[c]	18	5,440	15	Photographic equipment	655.2	12.0	11	22.2	7
53	Firestone	687[c]	21	5,284	13	Tires	112.9[d]	2.1	44	7.7	43
54	Dart Industries	627[c]	5	2,403	26	Basic chemicals	171.7[d]	7.2	24	16.2	30
55	Farmland Industries[e]	609[c]	10	3,860	16	Farm cooperative	93.4	2.4	42	20.2	11
56	Koppers	557[c]	15	1,828	30	Diversified chemical	86.5	4.7	33	14.7	34
57	Georgia-Pacific	542	58	5,207	10	Wood products	327	6.3	27	16.7	29
58	Cities Service	528	30	6,277	8	Petroleum	347.5	5.5	30	15.6	32
59	Esmark	516[c]	9	6,772	8	Meat products	92.4	1.4	47	11.1	40
60	General Tire	482[c]	7	2,295	21	Tires	81.7	3.6	38	8.2	42
61	Eli Lilly	471	40	2,206	21	Drugs	329.5	14.9	7	21.0	9
62	Texasgulf	464	36	789	59	Metal mining	136.9	17.4	2	15.7	31
63	Uniroyal	449	1	2,575	17	Tires	−120.5[d]	f	50	f	49
64	Alcoa	433[c]	17	4,847	9	Nonferrous metals	504.6	10.4	12	20.0	13
65	Kerr-McGee	420	12	2,683	16	Petroleum	160.0	6.0	29	13.2	36
66	Kaiser Aluminum	419	24	2,927	14	Nonferrous metals	232.2	7.9	19	19.0	16
67	International Flavors	409	12	409	100	Basic chemicals	61.5	15.0	5	21.5	8
68	Freeport Minerals	402	58	488	82	Nonmetallic minerals	101.4	20.8	1	26.7	4
69	Badische	398	25	398	100	Basic chemicals	15.5	3.9	36	11.0	41
70	Standard Oil (Ohio)	398	22	7,916	5	Petroleum	1186.1	15.0	6	38.4	2
71	Cabot	387	20	1,122	34	Specialty chemicals	70.4	6.3	28	18.4	18
72	Pfizer	384	11	2,746	14	Drugs	237.9	8.7	15	16.8	27
73	Merck	381[c]	20	2,385	16	Drugs	381.8	16.0	3	22.9	6
74	El Paso	334	62	3,089	11	Natural gas	138.1	4.5	34	17.4	22
75	North American Philips	329[c]	4	2,409	14	Electrical products	81.7	3.4	39	14.3	35
76	Internorth	327	39	2,499	13	Natural gas	185.5	7.4	21	17.2	25
77	Airco	325	18	911	36	Basic chemicals	67.6	7.4	22	na	na
78	GAF	301	21	1,213	25	Photographic equipment	28.2	2.3	43	7.6	44
79	Upjohn	301	16	1,508	20	Drugs	149.5	9.9	13	20.1	12
80	American Petrofina	297	77	1,587	19	Petroleum	83.2	5.2	31	19.3	15
81	Liquid Air	272	47	369	74	Basic chemicals	24.7	6.7	25	11.8	37
82	Mississippi Chemical	265	7	265	100	Farm cooperative	23.8	9.0	14	17.2	24
83	Witco Chemical	264	14	967	27	Basic chemicals	42.8	4.4	35	18.1	20
84	Emhart	258	19	1,346	19	Machinery	70.2	5.2	32	16.9	26
85	Thiokol	257[c]	38	557	46	Aerospace	40.1	7.2	23	19.6	14
86	Martin Marietta	243	19	2,061	12	Aerospace	178.0	8.6	16	18.4	19
87	Vulcan Materials	242	7	748	32	Nonmetallic minerals	63.8	8.5	17	20.9	10
88	Terra Chemicals	241[c]	29	254	95	Agricultural chemicals	2.7	1.1	49	5.9	46
89	Beker Industries	228	13	228	100	Agricultural chemicals	36.4	16.0	4	39.7	1
90	SCM	221[c]	16	1,754	13	Paint	47.4	2.7	40	11.4	38
91	Royster	197	41	228	87	Agricultural chemicals	3.0	1.3	48	4.4	48
92	Houston Natural Gas	195	11	1,798	11	Natural gas	138.6	7.7	20	19.0	17
93	Northwest Industries	192	2	2,580	7	Conglomerate	172.2	6.7	26	17.3	23
94	Engelhard Industries	177[c]	14	18,080	1	Commodity trading	349.7	1.9	45	31.0	3
95	Big Three Industries	173	21	509	34	Basic chemicals	62.9	12.4	9	15.6	33
96	Petrolite	172	15	187	92	Specialty chemicals	15.6	8.3	18	16.7	28
97	Loctite	161	26	161	100	Specialty chemicals	23.3	14.4	8	25.2	5
98	First Mississippi	157	9	178	88	Agricultural chemicals	4.7	2.6	41	4.9	47
99	Getty Oil	147	17	4,986	3	Petroleum	604.4	12.1	10	17.7	21
100	Stepan Chemical	145	18	145	100	Detergent chemicals	5.3	3.7	37	11.4	39

a Net income as percentage of net sales. **b** Net income as percentage of year-end stockholders' equity. **c** Chemical sales include significant amounts of nonchemical products such as fabricated plastics, coatings, metals, drugs, and the like. **d** Net income includes major nonrecurring items—Firestone $35.2 million credit, Dart Industries $48.4 million (pretax) credit, Uniroyal $87.9 million (pretax) charges. **e** Net income given as "savings," stockholders' equity as "capital shares and equities." **f** deficit. **na** = not available. **Note:** Data are for calendar year or for company fiscal year ending in 1979.

though there are 29 chemical companies of one kind or another among the Top 50, there are only 19 in the second 50.

Equally notable is the diminished role of oil and gas companies in the smaller company group. Petroleum companies have moved up steadily on the senior list, to the point that six of them are in the first 15 positions, with Exxon number three behind only Du Pont and Dow Chemical.

However, in the second 50, there are only eight petroleum companies, led by Cities Service. Three of these are heavily centered in natural gas—El Paso, Internorth, and Houston Natural Gas.

From these two clusters in chemical and oil companies, the second 50 list scatters through 13 other industry categories, running from heavy machinery and aerospace to conglomerates and commodity trading. Two of these with a notable presence are tires and drugs.

Since the second 50 list is so dispersed throughout U.S. industry, it would be expected that the chemical influence in these firms would be less than in the Top 50 companies. The average unweighted chemical part of total sales in the second 50 is 37%, below the 49% average for the Top 50.

Though operating from a smaller sales base, the second 50 chemical operations grew relatively less in 1979 than did the Top 50, largely because of the weight of booming petrochemicals in the larger companies. Average unweighted growth among the second 50 chemical operations was 22% in 1979 compared to 26% for the Top 50.

However, the smaller 50 companies show their strength on the bottom line as do smaller companies in numerous other financial comparisons with larger chemical producers (see C&EN's scan of comparative financial ratios of 40 major chemical companies, June 9, page 47). For total company results, profit margin on sales for the second 50 averaging 7.5% in 1979 (median 6.7%) is a cut above the average 6.1% (median 5.9%) for the Top 50 companies.

The difference narrows in average return on stockholders' equity. For the second 50, average ROE at 17.1% is still above the average 16.5% for the Top 50. Respective medians are 16.9% and 15.7%.

This recession year won't offer many of these companies a chance to repeat 1979 performance. However, growth like this in the business expansion just ended shows plenty of investment and profitability in smaller chemical company operations. □

CHECKOFF

MERGERS

■ **Allied Chemical**—Sells its Minerva fluorspar mining complex, Cave-In-Rock, Ill., to Inverness Mining Co. for cash and notes; terms not disclosed. Allied had closed two mines and processing plants last year. Inverness, subsidiary of Seaforth Oil & Mineral, says it will reopen mines and bring them to full production within three months.

■ **Cabot Corp.**—Agrees in principle to sell its machinery division to Ingersoll-Rand for $130 million and assumption of certain liabilities. Division manufactures mobile equipment for drilling, service, and workover of oil and gas wells and manufactures high-grade steel products. Cabot will use proceeds to fund capital expenditures to fund oil and gas exploration and development and expansion of its specialty metals businesses.

■ **Dow Chemical**—Completes sale of Tennessee operations of its Hydroscience subsidiary, based in Knoxville, to IT Corp., hazardous waste management firm. Hydroscience, involved in development, design, and engineering of solids, thermal, and air pollution control systems, will be known as IT Enviroscience Inc. Terms not disclosed.

■ **Du Pont**—Cancels merger discussions with Shipley Co. of Newton, Mass.

■ **W. R. Grace**—Purchases National Kaolin Products Co. of Aiken, S.C., for $5.5 million in Grace common stock. National Kaolin, supplier of air-floated clay to rubber industry where it is used as filler in batching of synthetic and natural rubbers, had 1979 sales of about $1.8 million.

Grace also acquires McDonald Rental Tools of Lafayette, La., and DCI Inc. of Tulsa, Okla., both oil field service companies. McDonald was acquired for $16.5 million in cash; DCI for $4.1 million in Grace common stock.

■ **Guardsman Chemicals**—Agrees in principle to acquire all outstanding stock of Technical Research for cash, notes, and stock. Technical Research, with annual sales of about $4 million, manufactures industrial finishes and operates manufacturing facility in Seattle area, with markets in Northwest.

■ **Hercules**—Signs letter of intent providing for purchase of its St. Paul Equipment division by Allpak Ltd. of London, Ont. St. Paul Equipment makes filling equipment for dairy, juice, food, cosmetic, and household chemical products. Purchase, subject to approval by both managements, will become effective July 28.

Hercules subsidiary Haveg Industries sells its manufacturing facility at Santa Fe Springs, Calif., to group of investors including many plant employees. Plant makes custom-molded reinforced plastic structures for industries such as aerospace and electronics. New company to be called Haveg-Reinhold Inc.

■ **International Minerals & Chemical**—Sells certain assets that had comprised its 40,000 ton-per-year sodium chlorate plant at Orrington, Me., to Stamchem division of PPG Industries Canada. Sale includes process machinery and ancillary equipment which Stamchem will move to its Beauharnois, Que., site; terms of sale not disclosed.

■ **Interox America**—Acquires all of Shell Chemical's hydrogen peroxide rolling stock and services of Shell's major terminal storage facilities.

■ **PQ Corp.**—Sells its QURAM quaternary ammonium product to Emery Industries, subsidiary of National Distillers. Agreement covers PQ's entire QURAM business including patented technology, production equipment, and trademark; terms not disclosed.

■ **Thiokol**—Completes purchase of Cincinnati Milacron's wholly owned subsidiary Cincinnati Milacron Chemicals, and related distribution assets outside U.S.; purchase price of $52 million in cash.

■ **Union Carbide**—Agrees to sell its Gamma Camera product line to Trans Union Leasing Corp.; terms not disclosed.

Polyurethane use may grow 9% annually

U.S. will account for almost 80% of 1980's expected use of some 2.8 billion lb in western hemisphere; fastest growth will be in elastomers

Overall polyurethane demand throughout the western hemisphere is expected to exceed 4.3 billion lb in 1985. If that prediction is realized, it means that use of the polymer will grow at an average rate of more than 9% annually.

The countries in this hemisphere all are subject to challenges that will impinge on their polyurethane markets, according to Peter J. Manno, manager of commercial development and market research at Upjohn's polymer chemicals division in La Porte, Tex. He cites inflation, dollar devaluation, and rising oil prices. Many of them have high unemployment and low living standards.

Manno presented this market analysis at an International Conference on Cellular and Noncellular Polyurethanes that drew 1300 delegates to Strasbourg, France. The meeting was cosponsored by the (U.S.) Society of the Plastics Industry and by West Germany's Fachverband Schaumkunststoffe (Union of Foamed Plastics).

Demand for polyurethanes may grow fastest in Venezuela

Millions of lb	1980	1983	1985	Average annual growth, 1980–85
U.S.	2191.2	2877.6	3429.8	9.4%
Canada	160.6	198.0	233.2	7.7
Brazil	158.4	180.4	209.0	5.7
Mexico	105.6	136.4	180.4	11.3
Argentina	52.8	61.6	70.4	5.9
Venezuela	50.6	72.6	92.4	12.8
Others[a]	61.6	79.2	96.8	9.5
TOTAL	2780.8	3605.8	4312.0	9.2%

a Other Caribbean, Central and South American countries. Source: Upjohn Co.

Indeed, since preparing his paper last fall, Manno has scaled down his estimates of 1980 polyurethane consumption, because of the effects of the deepening recession, particularly in the U.S. But he is optimistic that recovery will be evident by 1983, and that his 1985 forecasts will hold.

The U.S., where polyurethane consumption is by far the highest, will account for nearly 80% of this year's expected use of more than 2.8 billion lb in the western hemisphere. Then follow Canada, with 6% of total consumption, Brazil 6%, Mexico 4%, Argentina 2%, and Venezuela 2%. The other countries collectively account for the balance. The pattern should be much the same in 1985, except that Venezuela probably will have moved ahead of Argentina.

Venezuela, in fact, will experience the fastest rate of annual polyurethane growth in the coming five years, at nearly 13%. Mexico will come a close second, averaging more than 11% per year. "Venezuela," Manno notes, "is beginning to export polyurethane products to neighboring South American countries. And Mexican demand for consumer products is growing sharply."

Foams, both flexible and rigid, comprise the bulk of polyurethane sales. Demand throughout the Americas this year, according to Manno, likely will exceed 1.8 billion lb, almost 66% of total polyurethane use in these countries. Sales of elastomers, the next most important single class of polyurethanes, likely will be about 257 million lb this year, slightly more than 9% of the total. The 693 million lb balance, almost 25% of the total, consists of a variety of polyurethane-based formulations used in adhesives, coatings, sealants, and other applications.

Looking ahead, Manno predicts that foams will undergo an annual growth of more than 8% per year to some 2.7 billion lb in 1985, 63% of the total polyurethanes used that year throughout the hemisphere. Elastomers will grow faster, approaching 12% per year to about 449 million lb, or 10% of the total. Demand for other products will expand about 10% per year to more than 1.1 billion lb in 1985.

The bulk of the flexible foams go to make cushion fillings and mattresses. This market has been hard hit by the slowdown in construction and home sales, which has caused a drop in demand for furnishings and bedding, Manno says. Flexible foams, together with rigid foams, also are used in auto interiors for seats and protective padding.

C&EN staff photos

Manno: 1985 forecasts will hold

Rigid polyurethane foams are employed in buildings because of their desirable thermal insulation properties. "A recent outlet in the U.S. that has proven to be quite excellent is use of rigid foam sheets in residential homes," Manno says. These sheets are less than an inch thick with an

Leis: big growth in autos

outer skin of aluminum foil. They provide a high level of insulation, increasingly important in light of the rising costs of heating and air conditioning.

Although sales of rigid polyurethane foam for building and construction likely will increase 15% per year through 1985 in the U.S. from the present 271 million lb, growth rates in Venezuela and Mexico will be even faster. Admittedly starting from lower bases, in Venezuela the growth rate is expected to be 20% per year (from 4 million lb now), and nearly 19% in Mexico (from close to 7 million lb).

The thermal barrier characteristics of polyurethane foams is the reason, too, for their increasing use both in home refrigerators and freezers, and in commercial refrigeration units. By Manno's estimates, 80 to 85% of U.S.-made refrigerators and about 90% of freezers use them. This outlet will amount to 110 million lb in 1980 in the U.S. alone—73% of consumption in the Americas—and could grow almost 8% annually in the next five years. The fastest yearly growth rate will be in Mexico (19% from the present consumption level of 7 million lb) and Argentina (15% from 2 million lb).

Autos will provide an increasingly important outlet for polyurethane elastomers, Manno says. He cites the weight savings, which will result in economies in gasoline consumption, and the styling flexibility.

Donald G. Leis, senior marketing consultant for Union Carbide's silicones and urethane intermediates division in New York City, shares this opinion. By 1990, he predicts, the amount could grow more than fourfold to nearly 331 million lb from the 68 million lb of polyurethane elastomer used in 1979 U.S. models.

"As the weight of the [U.S.-made] car is reduced [from an average of 4200 lb to 2600 lb in 1990], total use of plastics will increase 137% per car, and total use of urethane materials will increase 147% per car," he told the Strasbourg meeting. "This growth of urethane materials can be achieved only by continued development of the reaction injection-molding (RIM) process, and the successful commercial production of RRIM (reinforced rim) materials."

RIM is a recently developed technique involving injection of automatically metered urethane components into a mold. In RRIM a filler, such as glass fiber, is employed. "Currently, the material of choice for potential external automotive body parts is made from high-modulus urethane elastomer with between 15 and 25% milled glass fiber to give product with a flexural modulus of 1.7 to 2.1 MegaPascals," Leis notes.

"RRIM urethane elastomer should become a future major use for urethanes," he says. External body parts are 50% lighter than corresponding metal ones, have better corrosion resistance, and can withstand damage. "We project use of 4 lb per car in 1985, and 8 lb per car by 1990 if successful production can be achieved."

Automotive applications currently being considered for RRIM urethanes are fenders and door panels, according to Leis. "By 1981, there will be at least eight RRIM machines in the [U.S.] automobile industry," he says. "These will be captive machines, all dedicated to development of production of prototype parts. Something has to happen from that."

In one of the keynote addresses, Günther Oertel, head of Bayer's polyurethane applications department in Leverkusen, West Germany, provided some pointers on how he sees outlets for polyurethanes. One, for instance, is the possibility of molding shoe soles, or, indeed, complete shoes, by RIM technology.

Industrialized countries are finding it increasingly difficult to compete in price with shoes coming from countries where labor costs are very much lower, he notes. He sees a switch to RIM technology, with its fast cycle times and reduced labor requirements, as a possible answer.

Oertel: significant new uses

Replacement of conventional auto paints with ones based on polyurethane formulations is another area that could open up significant markets. Polyurethane paints, Oertel points out, cure rapidly at about 80° C in contrast to the 120° to 160° C needed for existing paints. "Right now, it's an untouched market," he says. In fact, he says, one auto company, which he won't name, plans to use polyurethane paint on its autos next year. "This should provide a strong push to the market."

Oertel touched on a sensitive issue for polyurethanes—their flammability. He urges wider study of the use of such inorganic fillers as mica or aluminum hydroxide. "These improve fire resistance to a significant extent," he notes. Besides, he adds, such materials add physical strength to polyurethane parts.

Another potentially fruitful area of research involves the polymerization reaction itself. Polyurethanes are made by interacting a diisocyanate with a polyether derived from propylene glycol. The blending of such a polyether with a second one, based, for example, on ethylene glycol, results in an emulsion. "The effect of a two-phase polyether system isn't fully realized," he says. "It should lead to a network of two elastomers, a two-phase system with completely different properties."

Neither has the blending of polyurethanes with other polymers been investigated in any detail, he adds. "Nobody knows what advantages or disadvantages might arise from blending 60% high-quality polyurethane elastomer with, say, 30% high-density polyethylene and 10% acrylonitrile-butadiene-styrene." These are some avenues his company is exploring, he hints. □

Construction will pace polyurethane use in Americas

Millions of lb	1980	1983	1985	Average annual growth, 1980–85
Foams				
Furniture & bedding (flexible)	899.8	1053.8	1234.2	6.5%
Transportation (flexible & rigid)	464.2	574.2	635.8	6.5
Construction (rigid)	314.6	490.6	633.6	15.0
Refrigeration (rigid)	151.8	198.0	231.0	8.8
Elastomers[a]	257.4	363.0	448.8	11.8
Others[b]	693.0	926.2	1128.6	10.3
TOTAL	**2780.8**	**3605.8**	**4312.0**	**9.2%**

a Includes footwear. b Includes appliances, foundry core binders, carpet underlay, fibers, textile laminates, and packaging. **Source:** Upjohn Co.

Inflation undercuts chemists' salaries

Very few chemists are without jobs this year and salaries are about 7% higher than they were a year ago, but surging living costs have more than wiped out the gain

For U.S. chemists, the employment situation continued to look very favorable during the early part of 1980. Very few chemists were unemployed and looking for work last March. And those with jobs were earning higher salaries than ever before. Nevertheless, the most recent ACS survey of the economic status of its members indicates that their salaries continue to be eroded by soaring living costs, as has been true generally for the past seven years.

Overall, in March, the median salary for chemists (that which is exceeded by 50% of those surveyed) was 7% higher than it had been 12 months earlier. Ph.D.'s salaries made a slightly better advance; chemists whose highest degree is either a B.S. or an M.S. did not do quite so well.

But living costs, as measured by the Department of Labor's consumer price index, were up a whopping 15% over the same 12-month period. Hence, on a constant-dollar basis, salaries have actually fallen about 7% during the year. That's the biggest bite inflation has taken out of chemists' salaries in at least the past quarter of a century. After adjustment for price increases in recent years, chemists' median salaries this year are nearly 20% lower than they were in 1973. They are, in fact, at about the same level as they were in the early 1960's.

No single chemist, of course, remains at the overall median throughout his or her career. Individual salaries, for one thing, depend on experience, with younger chemists typically earning less than the median while older chemists earn more.

Thus, in 1975 the median salary for a chemist who had gone to work after graduating with a B.S. degree in 1967 was $15,100 a year. In 1980, now 13 years after graduation, his salary, if he earns the median, is $23,450, 55% more. His salary has gone up about 9% a year. During the same period, meanwhile, consumer prices have increased about 52%. So his salary hasn't declined, in real dollars. But after five years of work, he essentially is earning just about the same as before. Ten years ago, this "median" chemist would have had a salary of $10,000 a year. Now, he is making about 135% more, for an average annual gain again of 9%. But with the cost of living nearly 110% higher, his current salary, in 1970 dollars, comes to merely $11,200, which works out to an increase of only about 1% a year.

If he were older, he likely would have fared even worse. The median salary this year for a B.S. chemist who obtained his degree 33 years ago is $30,000. That's 36% more than he had been making five years earlier and

Nearly all ACS members were employed last March. . .

Employment status[a]	Chemists: Total	By sex: Men	By sex: Women	By highest degree: B.S.	By highest degree: M.S.	By highest degree: Ph.D.	By minority status: Minority[b]	By minority status: Nonminority	Chemical engineers	All ACS members[c]
Employed full-time	94.9%	95.8%	88.6%	95.6%	95.9%	94.3%	92.9%	95.0%	96.9%	94.8%
Employed part-time	1.0	0.6	3.6	1.3	1.4	0.7	0.6	1.0	1.0	1.1
Postdoctoral or fellowship	2.2	2.0	3.3	0.1	0.2	3.8	4.6	2.0	0.2	1.9
Unemployed										
Seeking employment	0.9	0.7	1.8	1.4	1.0	0.6	1.4	0.8	0.5	1.0
Not seeking employment	1.1	0.9	2.7	1.7	1.6	0.6	0.5	1.1	1.4	1.1

a As of March 1, 1980. b Black, American Indian, Asian or Pacific, Hispanic. c Includes members whose highest degree and present work is in neither chemistry nor chemical engineering.
Source: ACS survey

. . .but their salaries were only moderately higher than previous year

$ Thousands	1980	1979	1978	1977	Change, 1979–80
CHEMISTS' MEDIAN SALARIES					
B.S	$25.0	$23.5	$22.0	$21.0	6%
M.S.	26.0	25.0	24.0	22.0	4
Ph.D.	31.2	29.0	27.4	26.0	8
Weighted average					7%

$ Thousands	1980	1979	1978	1977	Change, 1979–80
CHEMICAL ENGINEERS' MEDIAN SALARIES					
B.S.	$35.0	$31.7	$30.0	$28.0	10%
M.S.	35.0	31.5	32.0	30.0	11
Ph.D.	38.0	35.0	32.0	30.0	9
Weighted average					10%

Source: ACS survey

Joblessness among chemists remains at low level

Employment status, total U.S.[a]	1980	1979	1978	1977	1976
Employed full-time	95.9%	95.0%	95.7%	95.4%	94.7%
Employed part-time	1.0	2.0	1.0	1.1	1.3
Postdoctoral or fellowship	2.2	1.9	1.9	2.1	2.2
Unemployed	0.9	1.1	1.4	1.5	1.9

a Excludes unemployed chemists not seeking employment. Source: ACS survey

% Unemployed, by region[a]	1980	1979	1978	1977	1976
Pacific	1.5%	1.5%	2.6%	2.3%	3.0%
Mountain	0.9	0.3	1.7	2.7	2.2
West North Central	0.5	1.0	1.6	0.9	1.0
West South Central	1.0	0.9	0.8	1.0	0.7
East North Central	0.6	1.0	1.1	1.2	1.3
East South Central	0.2	0.3	0.8	0.7	1.5
Middle Atlantic	0.8	1.4	1.3	1.7	2.4
South Atlantic	1.0	1.3	1.5	1.2	1.5
New England	0.9	1.3	1.8	1.6	2.7

about 80% more than he would have been earning in 1970, assuming he had remained at the median during the decade. These increases are far below the concurrent rise in consumer prices during the same period. In fact, the $16,500 salary of this chemist in 1970, 23 years after he went to work with his new B.S. degree, has shrunk to just $14,300 this year when measured by the buying power of 1970 dollars.

If chemists' earning power has been eroded by inflation during the 1970's, their job security has improved a bit, at least compared to eight or nine years ago. This March, only 0.9% of the chemists responding to the 1980 ACS survey of the job situation for the chemical profession were unemployed and looking for work, down slightly from the 1.1% rate of a year earlier. This is the lowest unemployment rate since ACS began such surveys of its members in 1971. The unemployment rate for chemists has been falling each year since 1976, when 1.9% were out of work. The peak level of unemployment was 3.2% in 1972.

Joblessness among chemists has been consistently far below that for the total U.S. labor force. Last March, 6.2% of all civilian workers were unemployed. The national rate of unemployment had been hovering around 6% or slightly below for about two years. Since then, however, it has suddenly climbed as the U.S. economy sank deeper into recession. Last month, it reached 7.8%, the highest rate since late 1976.

Whether the current swift and sharp surge in joblessness nationwide will result in higher unemployment for chemists as well cannot yet be substantiated. But in the two most recent periods when unemployment rose rapidly in the U.S., during the recessions of 1970 and 1974–75, a smaller but still quite distinct increase in job losses struck chemists also.

Nevertheless, the job market has remained unusually strong for chemists throughout the first half of 1980, at least insofar as strength is reflected by the volume of advertising for job openings. C&EN is the major U.S. publication for classified ads listing positions available to chemists and chemical engineers. During the first five months of 1980, it carried 29% more such ads than in the like period of the previous year. Job ads in C&EN have not been so high any time since 1967. In May alone, ad volume was 43% higher than during the same month of 1979. However, preliminary figures for June hint, although still inconclusively, that a decline now may be beginning in ad volume.

Unemployment is generally at rock-bottom levels for chemists, no matter where or for whom they work or what they do. It appears to be a bit higher in the Far West than elsewhere, as has been the case during the three previous years. But the variation from one geographical area to another is not especially great. It is higher, too, although not markedly so, for younger chemists, as also was true during the three previous years.

Fewer women chemists, too, are unemployed but looking for employment this year than for any other year since the ACS survey began, although the rate for women, at 1.8%, continues

Salaries paid by industry tend to be above average at all levels of education and experience

CHEMISTS' ANNUAL SALARIES ($ THOUSANDS)[a]

Years since B.S. degree	0 to 1		2 to 4		5 to 9		10 to 14		15 to 19		20 to 24		25 to 29		30 to 34	
Percentile	All	Industrial	All	Industrial	All	Industrial	All	Industrial	All	Industrial	All	Industrial	All	Industrial	All	Industrial
25%																
B.S.	$13.2	$14.6	$14.5	$15.4	$17.0	$18.3	$20.0	$21.0	$23.0	$23.5	$25.0	$25.2	$26.5	$28.0	$25.0	$26.0
M.S.	—	—	14.5	17.1	17.0	19.2	20.0	22.1	22.1	25.5	23.0	27.0	26.0	28.8	26.2	29.0
Ph.D.	—	—	—	—	20.7	25.0	21.5	27.0	24.0	31.0	25.2	33.6	28.8	36.0	29.8	36.1
MEDIAN																
B.S.	16.2	17.4	17.0	17.2	20.0	21.0	23.4	24.0	28.0	28.1	30.0	30.0	31.2	32.9	30.0	31.2
M.S.	—	—	18.2	19.2	20.5	21.6	24.0	25.0	28.0	30.0	28.8	33.0	31.0	33.6	33.2	35.0
Ph.D.	—	—	—	—	25.5	26.8	27.0	30.0	30.5	36.0	32.4	39.0	36.0	42.0	38.0	42.9
75%																
B.S.	18.5	18.7	18.8	19.6	23.6	24.5	28.0	28.5	33.0	33.5	34.9	35.0	38.0	40.0	37.5	40.0
M.S.	—	—	20.0	21.7	24.0	24.5	27.9	29.5	33.2	36.0	35.8	40.0	39.3	41.0	39.0	40.0
Ph.D.	—	—	—	—	28.0	29.0	32.0	34.1	38.0	41.3	40.0	45.0	44.5	50.0	48.0	53.3

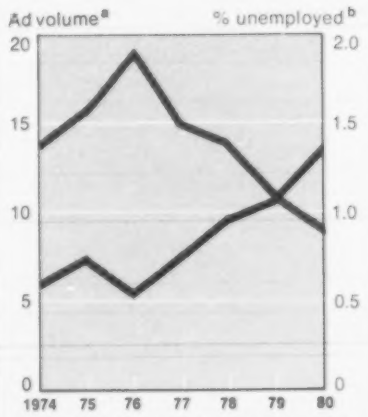
a As of March 1, 1980. **How to read this table**: Using as an example B.S. chemists two to four years after having received their B.S. degree, 25% of these chemists earn $14,500 a year or less, 50% earn $17,000 a year or less, and 75% earn $18,800 a year or less, as of March 1, 1980. **Source:** ACS survey

Unemployment slightly higher for chemists under 30

Age	% in category	% unemployed[a]
20–24	2.2%	1.9%
25–29	10.6	1.5
30–34	15.2	0.7
35–39	16.6	0.7
40–44	13.4	0.6
45–49	11.7	0.7
50–54	11.6	1.0
55–59	11.3	0.8
60–64	7.5	0.7

a As of March 1, 1980; excludes unemployed chemists not seeking employment. **Source:** ACS survey

Strong job market reflected in ads and unemployment



a Volume of help wanted advertising (in thousands of column inches) in C&EN for the 12 months ending with February of each year. b Per cent of chemists unemployed but seeking employment as of March 1 of each year.

Unemployment is low wherever chemists work

	% in category	% unemployed[a]
MOST RECENT EMPLOYER		
Industry	60.1%	0.9%
Chemical	20.7	0.9
Other	39.3	0.9
Education	24.9	0.5
Government	9.5	0.4
Nonprofit	4.6	1.8
Other	1.0	3.1
MOST RECENT WORK FUNCTION		
R&D	37.1%	0.6%
Teaching[b]	22.6	0.4
Management[c]	20.1	0.7
Marketing, production	11.8	1.7
Other	8.4	1.9
MOST RECENT WORK SPECIALTY		
Analytical	19.3%	1.1%
Organic	17.6	0.6
Polymer	11.2	0.5
Biochemistry	8.3	0.7
Pharmaceutical	8.0	1.0
Physical	6.9	0.6
General	6.9	0.9
Environmental	6.2	1.1
Inorganic	5.7	0.4
Other chemical	5.4	1.9
Agricultural, Food	4.6	1.3

a Excludes unemployed chemists not seeking employment. b In universities and colleges only. c Includes R&D management. **Source:** ACS survey

to be double or more than for men. As in earlier surveys, too, a considerably larger percentage of women than men are working part-time, doing postdoctoral work, or are neither working nor looking for work.

Chemists account for 80% of the respondents to the ACS survey. Just over half of the remaining 20% are working as chemical engineers, with the balance being ACS members whose highest degree is in some field other than chemistry or chemical engineering (such as business) and who are working neither as chemists nor engineers. Chemical engineers' unemployment rate of 0.5% is below even that for chemists. However, for members whose career is in a nonchemical area, the rate is a considerably higher 2.3%.

These data on the job status of the chemical profession are obtained from about 16,000 responses to a survey conducted by the Office of Manpower Studies of the ACS Department of Professional Relations & Manpower Studies in March of a sample of 26,000 ACS members. The sample was limited to members who are under 65 years of age, live within the 50 states of the U.S. or the District of Columbia, and are not student or emeritus members. In a special effort to measure in detail the economic status of women chemists, this year's survey covered nearly all women who belong to ACS.

As in the past, chemists working for private industry or the federal government tend to earn more than those employed by academic institutions, nonprofit organizations, or elsewhere. There is little distinction, however, between industry and government. The median salary of Ph.D.'s in industry is $36,000, a $1900 advantage over Ph.D.'s in government. On the other hand, medians for chemists whose highest degrees are either a B.S. or an M.S. are higher if they are federal employees than if they are industrial chemists.

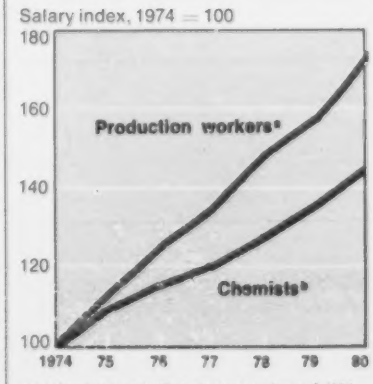
Approximately 60% of all chemists work in industry, and this year's survey provides information for the first time regarding differences in salaries among various industries. As would be expected, more industrial chemists (34% of the total) work for companies that manufacture chemicals than in any other industrial segment. Their salaries tend to be higher, also, than those of chemists working in other industries. The top dollar, however, is paid to chemists working for the petroleum industry, where 5% of industrial chemists are employed. Median salaries tend to be lowest for chemists with jobs with coatings producers, food companies, and nonmanufacturing firms.

Variations can be wide within a single industry, though. For example, salaries paid to Ph.D. chemists tend to be high—the median is second only to that in the petroleum industry—if they work for the pharmaceutical industry, which ranks second to the chemical industry in the number of chemists it employs. But the median salary for chemists whose highest degree is a B.S. or an M.S. is relatively low at pharmaceutical firms.

This year's ACS survey also pro-

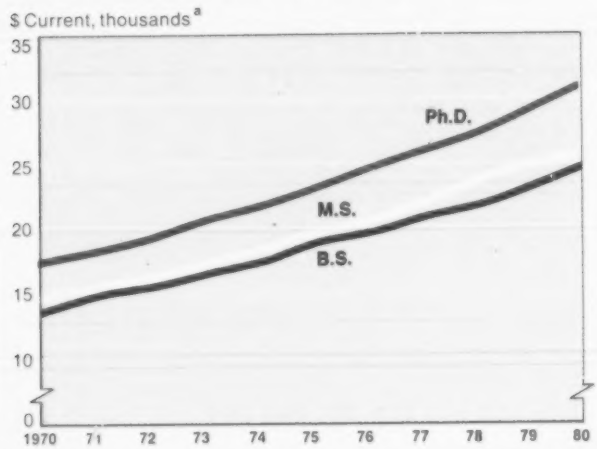
35 to 39		40 or more		Overall	
All	Industrial	All	Industrial	All	Industrial
$27.0	$27.3	$25.4	$28.4	$18.7	$19.7
25.0	28.0	24.9	27.5	20.1	22.8
30.0	37.0	30.0	36.1	25.0	29.5
34.0	35.0	31.5	32.0	25.0	25.2
32.1	35.0	30.9	31.0	26.0	28.5
40.0	44.0	40.0	46.0	31.2	36.0
43.5	44.0	41.9	43.2	32.0	33.0
40.0	42.1	40.0	40.0	33.8	35.7
49.0	54.4	50.1	59.0	40.0	44.0

Plant workers' wages outgain chemists' salaries

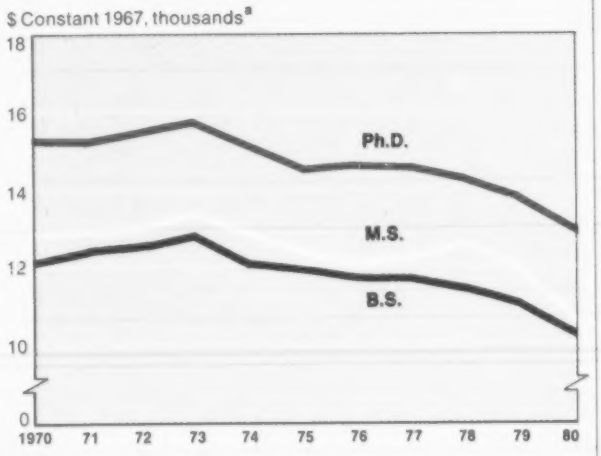


a In chemicals and allied products industry. b With B.S. degree. **Note:** Index based on data for March of each year. **Sources:** Department of Labor, ACS survey

Growth continues for chemists' salaries...



...but inflation obliterates the advance



a Median annual salary of chemists as of March of each year. **Source:** ACS survey

vides more insights regarding the range of salaries within the academic community than had been obtained previously. The results indicate that there is little difference between salaries paid by public or private universities that have graduate schools offering a Ph.D. in chemistry. About 60% of all academic chemists teach at such universities. For schools that do not confer the Ph.D., however, median salaries are higher at those that are public than at those that are private. The difference in salaries can be substantial between Ph.D.-granting universities and schools that do not offer such a degree. For example, the median salary for full professors at Ph.D.-granting schools, at $35,000, is 50% higher than that for professors of the same rank teaching at a private college where a B.S. is the highest degree in chemistry offered.

Salaries of women chemists continue to be well below those of their male colleagues, on the whole, whatever type of work they do or wherever they are employed. The median salary for women with a B.S. degree, for example, is $19,100 a year, compared to $26,000 for men. For women with an M.S., the median is $21,500; for men it is $27,300. At the Ph.D. level, the women's median is $24,700; the men's median is $32,000. On the face of it, women appear to earn only 75 to 80% as much as their male counterparts. The spread between women's and men's salaries has narrowed, but not much, in recent years.

The differences in the overall medians, to be sure, at least in part re-

Chemists earn more working in industry or government, especially if they are managers

	B.S.				M.S.				Ph.D.			
$ Thousands[a]	All chemists	Men	Women	Women as % of men	All chemists	Men	Women	Women as % of men	All chemists	Men	Women	Women as % of men
BY EMPLOYER												
Private industry	$25.2	$26.8	$19.8	74%	$28.5	$29.1	$23.1	79%	$36.0	$36.0	$28.8	80%
College/university	13.5	14.0	13.3	95	19.4	20.0	16.4	82	25.0	25.4	19.9	78
Federal government	28.4	30.0	21.3	71	29.8	30.5	24.7	81	34.1	34.6	30.3	88
Other	20.0	21.2	16.8	79	21.4	22.4	18.0	80	29.0	29.8	24.0	81
BY WORK FUNCTION												
General management	$33.0	$33.2	$24.8	75%	$36.0	$37.0	$28.8	78%	$40.0	$40.0	$30.3	76%
R&D management	34.8	35.0	26.2	75	37.0	37.5	27.8	74	43.0	43.0	34.8	81
Basic research	20.2	23.2	18.3	79	24.9	25.0	21.0	84	32.9	33.2	27.2	82
Applied R&D	24.0	25.1	19.5	78	27.0	27.6	22.5	82	31.7	32.0	27.9	87
Production and quality control	22.2	23.0	19.0	83	24.8	26.0	20.0	77	31.8	31.8	24.2	76
Marketing	29.8	30.0	19.9	66	30.0	32.0	23.7	74	38.0	38.0	27.0	71
Forensic	20.5	21.0	17.7	84	22.6	23.4	20.6	88	26.6	26.7	26.1	98
BY SPECIALTY												
Analytical	$23.0	$24.0	$19.2	80%	$26.0	$27.0	$22.0	81%	$29.6	$30.0	$25.3	84%
Organic	28.0	29.0	19.9	69	28.6	29.9	21.6	72	30.0	30.0	23.5	78
Polymer	28.0	28.9	20.0	69	29.4	30.0	22.4	75	37.0	37.2	27.2	73
Biochemistry	20.5	22.5	17.0	76	22.3	25.2	18.1	72	30.1	31.2	23.0	74
Pharmaceutical	22.0	24.0	18.9	79	26.5	27.0	24.0	89	36.0	36.8	28.8	78
Inorganic	27.0	28.0	19.7	71	28.1	28.2	20.0	71	28.3	28.6	23.0	80
Physical	24.0	25.4	18.6	73	30.0	30.0	25.0	83	30.0	30.3	25.0	83
Environmental	23.0	24.2	17.9	74	25.0	26.7	21.0	79	32.0	32.0	27.5	86
Agricultural, food	27.0	28.0	18.7	67	29.0	30.0	23.2	77	32.7	33.0	27.1	82

a Median salaries as of March 1, 1980. **Source:** ACS survey

flect differences in length of experience and in the type of work with which women chemists are most frequently involved. Salaries tend to be higher for older chemists, for one thing, who are much more likely to be men than women. For instance, only about 20% of women chemists received their B.S. degree in 1955 or before; nearly 40% of the men did, however. Conversely, 37% of the women but only 15% of the men have earned their B.S. since 1970.

In addition, a larger proportion of men (62%) than women (53%) work in industry, where salaries are higher. Women also are less likely than men to have relatively high-paying management jobs. (Median salaries rise dramatically as the number of subordinates, either direct or indirect, expands.) Only 12% of women chemists hold positions involving either general or R&D management, whereas 28% of the men do—and median salaries for the relatively few women that hold such jobs is only 75% that of male managers. In academic institutions, too, women are more likely to rank below men. Only 25% of women are full professors, whereas a third are assistant professors; among men, 55% are full professors, just 16% are assistant professors.

For younger chemists, though, the spread between men's salaries and women's salaries is not nearly so great. The median for women who have worked for two to four years after graduating with a B.S., for example, is $17,000 a year, identical with that for men in the same category. And the median for women with a Ph.D. and up to five years' experience is $25,000, only 2% lower than that for men with similar credentials. The median for women with a Ph.D. and up to five years' experience in industry actually is 2% more than that for similar men.

For both men and women, salaries tend to level off as they become older, especially if they do not have a Ph.D. This occurs about 25 years following graduation for chemists with a B.S. or an M.S. After that median salaries fluctuate at levels between $30,00 and $35,000 a year.

This plateauing is particularly evident for women chemists, even for those who have a Ph.D. The median for a woman with a B.S. who graduated between 1951 and 1955 is $25,450; for women who graduated between 1941 and 1945, it is the same. Women who graduated between 1941 and 1945 and then went on to earn a Ph.D. before working have a median salary of $27,800. That is only 7% more than women with a Ph.D. who received their B.S. between 1951 and 1955.

Industrial chemists earn highest salaries from oil firms

Industry	% of industrial chemists				Median salary ($ thousands)			
	All chemists	B.S.	M.S.	Ph.D.	All chemists	B.S.	M.S.	Ph.D.
Chemical	34%	29%	32%	39%	33.0	$27.5	$30.0	$36.1
Pharmaceutical	17	14	20	17	30.6	24.0	26.0	37.8
Coatings	6	8	5	4	28.0	24.0	25.3	32.5
Petroleum	5	5	4	6	34.1	28.6	32.0	39.0
Food	5	6	C	4	27.5	22.5	27.0	32.0
Metals	3	5	3	2	28.3	24.0	28.8	35.0
Rubber	3	4	3	2	32.5	28.4	31.4	36.0
Paper	2	2	1	2	32.0	25.0	29.9	35.0
Other manufacturing	19	21	19	18	30.2	25.0	28.4	36.0
Nonmanufacturing	6	6	7	6	28.5	21.0	27.8	34.0

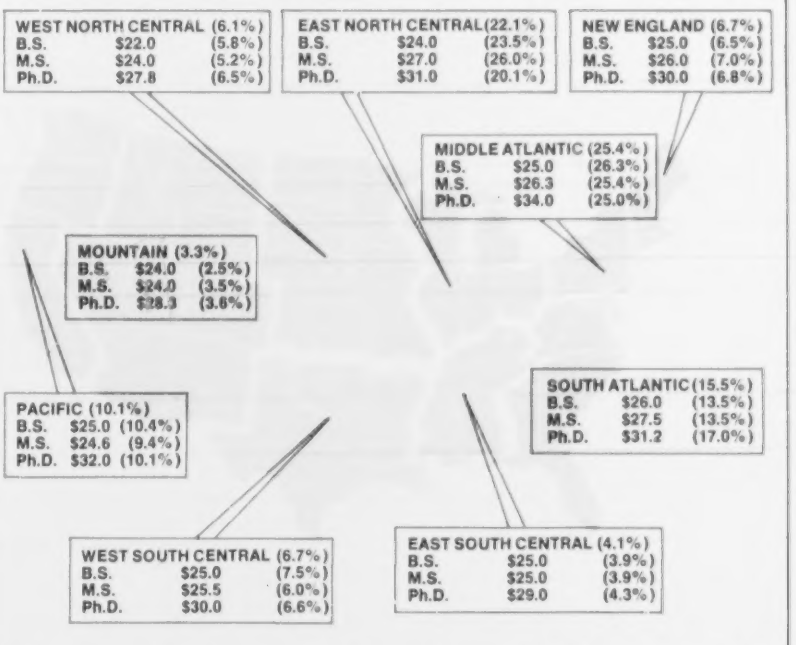
Source: ACS survey

Academic salaries are highest at Ph.D.-granting schools

Type of institution and highest degree awarded in chemistry	Median salary, Ph.D. chemists ($ thousands)			
	Professor	Associate professor	Assistant professor	All Ph.D. chemists[a]
PRIVATE				
Ph.D.	$35.0	$25.0	$20.5	$28.0
M.S.	27.0	20.8	—	22.6
B.S.	23.0	18.0	15.2	19.5
PUBLIC				
Ph.D.	34.5	25.0	20.0	28.0
M.S.	27.5	21.0	17.5	24.5
B.S.	26.0	21.0	16.9	23.0
ALL UNIVERSITIES AND COLLEGES[b]	30.0	22.0	17.8	25.0

a Includes instructors, unranked teachers, and nonfaculty employees. b Includes schools where highest degree offered in chemistry is Associate. Source: ACS survey

Chemists' salaries tend to be a bit higher in the East



Key to map: Using New England as an example, 6.7% of the responding chemists work in this geographical area; 6.5% of all whose highest degree is bachelor of science work there, and their median salary as of March 1, 1980, was $25,000 per year. **Note:** All salaries are in thousands of dollars. **Source:** ACS survey

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13–17	32.7	36.0	41.2
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33–47	43.0	42.3	51.0
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Source: ACS survey

Data from the ACS survey permit a rough calculation of the value of a Ph.D. degree. Assume that a chemist works in industry, that he earns the median salary for his level of experience, that median salaries rise generally in step with inflation (they have not done that well recently, but rose more rapidly throughout the 1960's), and that he retires at 65. If he starts working immediately after graduating with a B.S. degree, he will earn (in constant 1980 dollars) about $1.2 million during his career.

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